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REVERSIBLE WETTING OF NACL NANOPARTICLES AT RELATIVE HUMIDITIES BELOW DELIQUESCENCE OBSERVED BY ENVIRONMENTAL NON-CONTACT AFM

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ABSTRACT

The behavior of NaCl nanoparticles as a function of relative humidity (RH) was characterized by depositing particles on a prepared hydrophobic surface and measuring their height via non-contact environmental atomic force microscopy (AFM). Non-contact AFM allows greater sensitivity to changes in the size of particles than does contact AFM or scanning electron microscopy, and greater sensitivity to changes in shape than do mass-based techniques. Crystalline cubic NaCl nanoparticles with sides of 35 to 150 nm were found to reversibly take up water with increasing RH, and to form a liquid-like surface layer of thickness 2 to 4 nm at humidities well below the deliquescence point of 75.0% at 20°C. Measurable uptake begins at 70% RH. The maximum thickness of the layer increases with increasing RH for a given particle size and, for a given RH, increases with increasing particle size over the range studied. The liquid-like behavior of the layer is indicated by a reversible "rounding" at the tops of the particles, where the ratio of particle height to radius of curvature increases from zero (flat top) at 68% RH to 0.7 at 74% RH. These observations suggest that a reorganization of mass occurs on the solid NaCl nanoparticle, and hence that the behavior of NaCl aerosol nanoparticles at RH between 70 and 75% RH is more complex than an abrupt first-order phase transition. Theoretical treatments of the phase transition should therefore account for both the presence of a liquid-like layer prior to deliquescence, and the RH-dependent thickness of the layer.